Supporting Information

Two-photon absorption and emission in $CsPb(Br/I)_3$ cesium lead halide perovskite quantum dots

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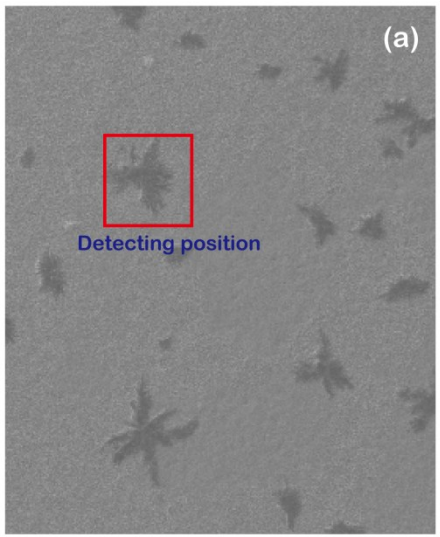

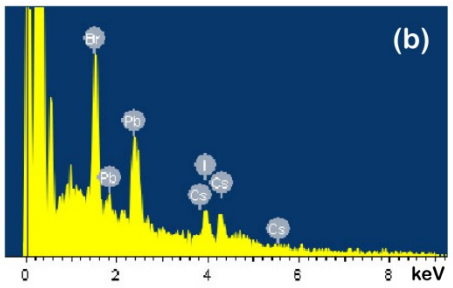

Table 1

Element	Atomic ratio (%)	Standard sample (1-Jun-1999)
Br L	42.89	KBr
I L	19.28	Not defined
Cs L	19.12	Not defined
Pb M	18.71	PbF_2

Fig S1. (a) Scanning electron microscopy image of the perovskite QDs on silicon wafers. The QDs may aggregate into bundles. (b) EDS spectra for the perovskite QDs. Table 1 presents the atomic ratio of the QDs. We can found that the proportion of Br and I in the perovskite QDs is about 2.07:0.93.

Section S2. The concentration of the perovskite QDs.

The concentration of the perovskite QDs are determined by the inductively coupled plasma atomic absorption spectroscopy (ICP-AAS). Firstly, 5 mL of perovskite QD toluene solution was placed in a beaker (10 mL), and then put it in a ventilated place. After complete volatilization of toluene, 2.5 ml of nitric acid (40%, vol.) and 2.5 ml of distilled water was added to the beaker to form a nitric acid solution. The solution was shaken on a shaker for 2 days to dissolve the ions thoroughly. By the ICP-AAS measurement, the concentration of the lead is about 15.5 ug/mL ($7.5*10^{-8}$ mol/mL). Combined with the average size of 14.5 nm and lattice spacing of 0.45 nm, we can obtained that the concentration of the perovskite QDs in toluene solution is about $6.34*10^{-12}$ mol/L.

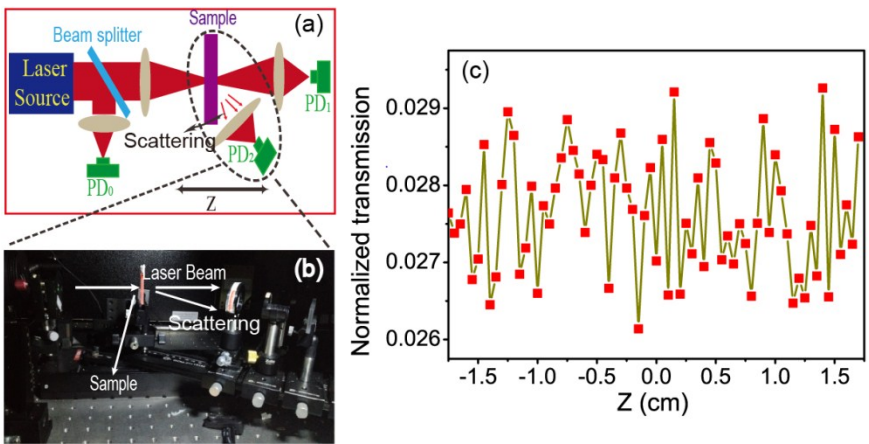

Fig. S2. (a, b) Z-scan experiment set-up: PD_1/PD_0 reflects the nonlinear properties of the samples and PD_2/PD_0 reflects the scattering signals. (c) Scattering results of the perovskite sample when we were carrying out the open-aperture Z-scans experiments.

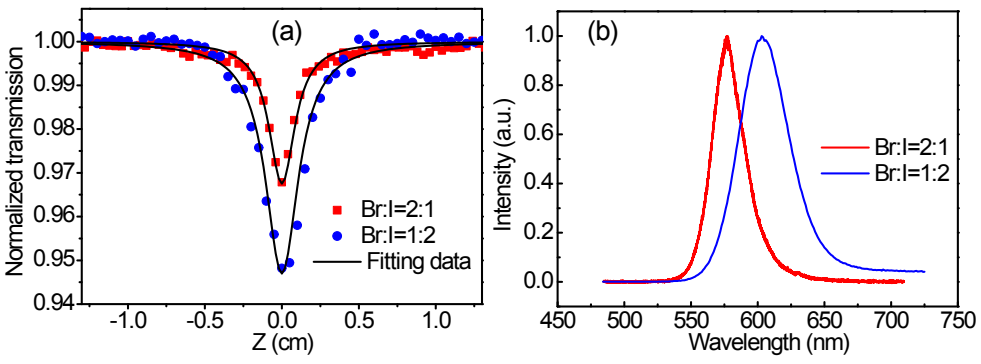

Fig S3. (a) The Z-scan results of the two perovskite QDs with different ratios of Br and I. (b) Normalized TP PL spectra of the two QDs. We can found that the TPA of the QDs with more I (0.061×10^{-2} cm/GW) is better than the QD with more Br ($0.055 \times 10^{-2}\ cm/GW$).